PATENT APPLICATION
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COMPRESSIBLE JAW CONFIGURATION WITH BIPOLAR RF OUTPUT ELECTRODES FOR SOFT TISSUE FUSION

BACKGROUND

1. Technical Field

The present disclosure relates to electrosurgical instruments and, more particularly, to open or endoscopic electrosurgical instruments having compressible or elastomeric end effector assemblies for use in sealing various tissues.

2. Background

A hemostat or forceps is a simple plier-like tool which uses mechanical action between its jaws to constrict vessels and is commonly used in open surgical procedures to grasp, dissect and/or clamp tissue. Electrosurgical forceps utilize both mechanical clamping action and electrical energy to effect hemostasis by heating the tissue and blood vessels to coagulate, cauterize and/or seal.

By utilizing an electrosurgical forceps, a surgeon can either cauterize, coagulate/desiccate and/or simply reduce or slow bleeding, by controlling the intensity, frequency and duration of the electrosurgical energy

applied through the jaw members to the tissue. The electrode of each jaw member is charged to a different electric potential such that when the jaw members grasp tissue, electrical energy can be selectively transferred through the tissue.

In order to seal large vessels, two predominant mechanical parameters must be accurately controlled - the pressure applied to the vessel and the gap distance between the electrodes - both of which are affected by the thickness of the sealed vessel to be sealed. More particularly, accurate application of pressure is important to oppose the walls of the vessel; to reduce the tissue impedance to a low enough value that allows enough electrosurgical energy through the tissue; to overcome the forces of expansion during tissue heating; and to contribute to the end tissue thickness which is an indication of a good seal. It has been determined that a typical fused vessel wall is optimum between 0.001 and 0.005 inches. Below this range, the seal may shred or tear and above this range the opposing tissue layers may not be properly or effectively sealed.

With respect to smaller vessels, the pressure applied to the tissue tends to become less relevant whereas the gap distance between the electrically conductive surfaces becomes more significant for effective sealing. With smaller vessels, the chances of the two opposed electrically conductive surfaces of the

electrosurgical forceps touching during activation increases as the size of the vessel becomes smaller.

The process of coagulating small vessels is fundamentally different than electrosurgical vessel sealing. For the purposes herein, "coagulation" is defined herein as a process of desiccating tissue wherein the tissue cells are ruptured and dried. "Vessel sealing" meanwhile is defined herein as a process of liquefying the collagen elastin and ground substances in the tissue so that it reforms into a cohesive, fused mass. Coagulation of small vessels is sufficient to permanently close the vessel lumen. Larger vessels need to be sealed to assure permanent closure.

U.S. Patent No. 2,176,479 to Willis, U.S. Patent Nos. 4,005,714 and 4,031,898 to Hiltebrandt, U.S. Patent Nos. 5,827,274, 5,290,287 and 5,312,433 to Boebel et al., U.S. Patent Nos. 4,370,980, 4,552,143, 5,026,370 and 5,116,332 to Lottick, U.S. Patent No. 5,443,463 to Stern et al., U.S. Patent No. 5,484,436 to Eggers et al. and U.S. Patent No. 5,951,549 to Richardson et al., all relate to electrosurgical instruments for coagulating, cutting and/or sealing vessels or tissue. However, some of these designs may not provide uniformly reproducible pressure to the opposing tissue layers which in turn may result in an ineffective or non-uniform seal. For example and with particular respect to variously-sized tissues, many of these references disclose instruments which

unevenly compress the tissue across the jaw surface which is not conducive to consistent or effective tissue sealing.

Many of these instruments rely on clamping pressure alone to procure proper sealing thickness and are not designed to take into account gap tolerances and/or parallelism and flatness requirements which are parameters which, if properly controlled, can assure a consistent and effective tissue seal. For example, it is difficult to adequately control thickness of the resulting sealed tissue by controlling clamping pressure alone for either of many reasons: 1) if tissue is initially thin or if too much force is applied, there is a possibility that the two electrically conductive surfaces of the instrument will touch and energy will not be transferred through the tissue resulting in an ineffective seal; 2) if tissue is thick or too low a force is applied, the tissue may pre-maturely move prior to activation and sealing and a thicker, less reliable seal may be created; or 3) if the tissue is thick, over compression may lead to tissue vaporization and a less reliable seal may be created.

Moreover, the performance of certain existing clamping RF delivery systems is limited due to their inherent tendency to arc and short once the directly opposing electrodes have been drawn into close proximity with one another. Maintaining a functional and reliable system with a directly opposed configuration requires tight tolerances on specific parameters such as electrode gap and jaw parallelism.

Thus, a need exists to develop an electrosurgical instrument which effectively and consistently seals variously-sized tissue and solves many of the aforementioned problems known in the art.

SUMMARY

The present disclosure relates to electrosurgical instruments having compressible or elastomeric end effector assemblies for use in sealing various tissues. In accordance with one aspect of the present disclosure, an electrosurgical instrument for sealing vessels includes a housing having a shaft attached thereto and an end effector assembly attached to a distal end of the shaft, wherein the end effector assembly includes first and second jaw members attached thereto. The jaw members are movable relative to one another from a first position for approximating tissue to at least one additional position for grasping tissue therebetween.

Preferably, each of the jaw members includes an elastomeric material disposed on an inner facing tissue contacting surface thereof. Each of the elastomeric materials includes an electrode disposed therein. Preferably, the electrodes are offset a distance X relative to one another such that when the jaw members are closed about the tissue and when the electrodes are activated, electrosurgical energy flows through the tissue in a generally coplanar manner

relative to the tissue contacting surfaces. Preferably, the offset distance X is in the range of about 0.005 inches to about 0.0.200 inches. It is envisioned that at least one of the jaw members includes means for regulating the distance X dependent upon tissue thickness or tissue type.

It is envisioned that the elastomeric material is either silicone, polyurethane or other thermoplastic elastomers such as santoprene (or combinations thereof). One or more of the above substances may also be combined to form an alloy with one or more of the following substances: nylon, syndiotactic polystryrene, Polybutylene Terephthalate (PBT), Polycarbonate (PC), Acrylonitrile Butadiene Styrene (ABS), Polyphthalamide (PPA), Polymide, Polyethylene Terephthalate (PET), Polyamide-imide (PAI), Acrylic (PMMA), Polystyrene (PS and HIPS), Polyether Sulfone (PES), Aliphatic Polyketone, Acetal (POM) Copolymer, Polyurethane (PU and TPU), Nylon with Polyphenylene-oxide dispersion or Acrylonitrile Styrene Acrylate. Preferably, the compressible material has a comparative tracking index (CTI) value of about 300 to about 600 volts.

It is envisioned that the electrosurgical system include at least one sensor which provides information to a feedback circuit for regulating the electrosurgical energy through the tissue. Preferably, the sensor measures at least one of tissue impedance, tissue temperature, tissue pressure, light transmission, and tissue thickness.

Preferably, at least one of the jaw members includes a plurality of electrodes across the width thereof and the electrosurgical instrument includes means for selecting one of the plurality of electrodes for electrically opposing the electrode disposed on the other of the jaw members. The selecting means includes a sensor which measures at least one of tissue impedance, tissue temperature and tissue thickness.

In one embodiment, the electrodes are wire electrodes which project from the tissue contacting surfaces of the elastomeric material into contact with the tissue. In another embodiment, the elastomeric material on each of the jaw members includes an electrode which is partially disposed therein. It is envisioned that upon grasping of tissue between the jaw members, each of the electrodes deflect inwardly relative to the tissue contacting surfaces in response to the tissue reaction forces.

In yet another embodiment, the electrodes are recessed within the elastomeric material. It is further contemplated that the tissue contacting surface of each electrode is substantially crowned.

In another aspect of the present disclosure, the electrosurgical instrument includes an end effector assembly attached to a distal end of the shaft. The end effector assembly includes first and second jaw members

attached thereto. The jaw members are movable relative to one another from a first position for approximating tissue to at least one additional position for grasping tissue therebetween.

In the present embodiment each of the jaw members includes an electrically insulative material (e.g., a material having a high CTI value) disposed on an inner facing tissue contacting surface thereof and an elastomeric material disposed between each jaw member and a respective insulative material. It is envisioned that the elastomeric material is may also be made from one or more electrically insulative materials. Each of the insulative materials includes an electrode disposed therein. The electrodes are offset a distance X relative to one another such that when the jaw members are closed about the tissue and when the electrodes are activated, electrosurgical energy flows through the tissue in a generally coplanar manner relative to the tissue contacting surfaces.

It is envisioned that the insulative material on each of the jaw members includes an electrode which is partially disposed therein. It is further envisioned that each of the electrodes are recessed within the insulative material.

Other objects and features of the present disclosure will become apparent from consideration of the following description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and features of the present invention will become apparent from the following detailed description considered in connection with the accompanied drawings. It should be understood, however, that the drawings are designed for the purpose of illustration only and not as a definition of the limits of the invention.

FIG. 1 is a perspective view of an exemplary electrosurgical instrument in accordance with the present disclosure, and associated with an electrosurgical generation;

FIG. 2 is a transverse, cross-sectional end view of one embodiment according to the present invention showing a pair of opposing jaw members each having a resilient tissue contact surface with an electrode housed therein;

FIG. 3 is a transverse, cross-sectional end view of another embodiment according to the present disclosure wherein the electrodes are partially housed within the resilient tissue contacting surface;

FIG. 4 is a transverse, cross-sectional end view showing a wire electrode disposed in each of the resilient tissue contacting surfaces;

FIG. 5 is a transverse, cross-sectional end view showing a resilient member disposed between the tissue contacting surface and an outer periphery of each of the jaw members;

FIG. 6 is a transverse, cross-sectional end view showing an alternate embodiment of the present disclosure wherein the electrodes are disposed on the same jaw member; and

FIG. 7 is a transverse, cross-sectional end view showing another alternate embodiment of the present disclosure wherein the jaw members include a series of stop members for controlling the gap distance between jaw members during sealing.

DETAILED DESCRIPTION

Preferred embodiments of the presently disclosed electrosurgical instrument are described in detail herein with reference to the drawing figures wherein like reference numerals identify similar or identical elements. In the drawings and in the description which follows, the term "proximal", as is traditional will refer to the end of the electrosurgical instrument which is closest to the operator, while the term "distal" will refer to the end of the instrument which is furthest from the operator.

Referring initially to FIG. 1, there is seen a perspective view of an electrosurgical instrument system in accordance with an exemplary embodiment of the present disclosure, generally indicated as reference numeral 10. Electrosurgical instrument system 10 includes an electrosurgical energy generator 12 and electrosurgical forceps 14. A cable 16 electrically connects forceps 14 to generator 12 via clips 18 and 20.

Forceps 14 include a housing 22, a handle assembly 24, a rotating assembly 26, a trigger assembly 28 and an end effector assembly 100 which mutually cooperate to grasp and divide tubular vessels and vascular tissue. More particularly, forceps 14 include a shaft 32 which has a distal end 34 dimensioned to mechanically engage end effector assembly 100 and a proximal end 36 which mechanically engages housing 22. While the illustrated forceps 14 are intended for use in minimally invasive endoscopic surgical procedures, the principles of the present disclosure are equally applicable to forceps designed for use in open surgical procedures.

Handle assembly 24 includes a fixed handle 40 and a movable handle 50. Fixed handle 40 is integrally associated with housing 22 and movable handle 50 is movable relative to fixed handle 40 as explained in more detail below with respect to the operation of forceps 14. Rotating assembly 26 is preferably attached to a distal end of housing 22 and is rotatable in either direction about a longitudinal axis "A" of shaft 32.

As mentioned above, end effector assembly 100 is attached to distal end 34 of shaft 32 and includes a pair of opposing jaw members 110, 120. Movable handle 50 of handle assembly 24 is ultimately connected to a drive rod (not shown) which, together, mechanically cooperate to impart movement of jaw members 110, 120 from an open position wherein jaw members 110, 120 are disposed in spaced relation relative to one another to a clamped or closed position wherein jaw members 110, 120 cooperate to grasp tissue therebetween.

It is envisioned that forceps 14 may be designed such that it is fully or partially disposable depending upon a particular purpose or to achieve a particular result. For example, end effector assembly 100 may be selectively and releasably engageable with the distal end 34 of shaft 32 and/or the proximal end 36 of shaft 32 may be selectively and/or releasably engageable with housing 22 and handle assembly 24. In either of these two instances, forceps 14 would be considered "partially disposable" or "reposable", i.e., a new or different end effector assembly 100 (or end effector assembly 100 and shaft 32) selectively replaces the old end effector assembly 100 as needed.

An exemplary electrosurgical energy generator 12 is disclosed in U.S. Patent No. 6,068,627 to Orszulak, et al. and available from Valleylab – a division of Tyco Healthcare, LP as the Ligasure™ vessel sealing generator and includes an identifying circuit (not shown) therein which is responsive to

information and which transmits a verification signal to generator 12 and further includes a switch (not shown) connected to the identifying circuit which is responsive to the signaling of the identifying circuit.

Each jaw member 110, 120 is manufactured from a sufficiently rigid material (i.e., stainless steel) which is resistant to deformation as a result of clamping forces acting thereon. Preferably, jaw members 110, 120 are manufactured from an electrically non-conductive material, such as, for example, a polymer, carbon-fiber, a ceramic-like material or a combination thereof (i.e., Teflon polytetreflouroethylene) which is also resistant to deformation forces.

Preferably, each jaw member 110, 120 is at least partially enveloped in an elastomeric material or shell 114, 124, respectively. As elastomeric material is defined herein as a macromolecular material that return rapidly to approximately the initial dimensions and shape after substantial deformation by a weak stress and release of the stress (strain ~ 100 to 200%). As seen in FIGS. 2-4, elastomeric shells 114, 124 substantially surround the outer periphery of jaw members 110, 120. Preferably, the elastomeric shells 114, 124, cover the opposing tissue contacting surfaces 115, 125 of jaw members 110, 120, respectively, and are dimensioned to at least partially house an electrode 116, 126 therein.

Preferably, the elastomeric shells 114, 124 are at least partially made from a compressible, electrically non-conductive elastomeric material having a high CTI (Comparative Tracking Index) value of about 300 to about 600 volts in order to reduce surface tracking and possible collateral damage to tissue. It is envisioned that the elastomeric material includes either silicone, polyurethane or another thermoplastic elastomers such as santoprene (or combinations thereof). It is also envisioned that one or more of the above substances may also be combined to form an alloy with one or more of the following substances: nylons and syndiotactic polystryrenes such as QUESTRA® manufactured by DOW Chemical, Polybutylene Terephthalate (PBT), Polycarbonate (PC), Acrylonitrile Butadiene Styrene (ABS), Polyphthalamide (PPA), Polymide, Polyethylene Terephthalate (PET), Polyamide-imide (PAI), Acrylic (PMMA), Polystyrene (PS and HIPS), Polyether Sulfone (PES), Aliphatic Polyketone, Acetal (POM) Copolymer, Polyurethane (PU and TPU), Nylon with Polyphenylene-oxide dispersion and Acrylonitrile Styrene Acrylate. Preferably, the elastomeric materials have a low moisture absorption (e.g., less than about 4%) in order to maintain material performance after continual use in fluid rich environments. It has also been discovered that certain coatings can be utilized either alone or in combination with one of the above materials in order to reduce other electrosurgical effects at the tissue contacting site, e.g., flashover.

Each electrode 116, 126 of jaw member 110, 120, respectively, is electrically coupled to generator 12 for delivering bipolar energy across the tissue

"T" when grasped. More particularly, electrode 116 is connected to a first electrical potential and electrode 126 is connected to a second electrical potential such that, when energized, electrosurgical energy is transferred through tissue "T" disposed between respective jaw members 110 and 120.

Electrodes 116, 126 are each at least partially disposed within respective elastomeric shells 114, 124 of each jaw member 110, 120 and are preferably disposed on opposite sides of jaw members 110, 120. More particularly, and as best seen in the end views of FIGS. 2-5, electrodes 116, 126 are spaced a transverse distance "X" from one another. Preferably, in accordance with the present disclosure, distance "X" is from about 0.005 inches to about 0.200 inches, a range of about 0.050 inches to about 0.150 inches is preferred to insure proper seal width. Accordingly, when jaw members 110, 120 are in the closed position, electrodes 116, 126 create an electrical path therebetween which is substantially coplanar to opposing tissue engaging surfaces 115 and 125 as will be explained in more detail below.

It is envisioned that the outer surface of electrodes 116, 126 may include a nickel-based material, coating, stamping, and/or metal injection molding which is designed to reduce adhesion between electrodes 116, 126 and the surrounding tissue during activation and sealing. Moreover, it is also contemplated that the tissue contacting surfaces of electrodes 116, 126 may be manufactured from one (or a combination of one or more) of the following

materials: nickel-chrome, chromium nitride, MedCoat 2000 manufactured by The Electrolizing Corporation of OHIO, Inconel 600 and tin-nickel. It is further envisioned that tissue contacting surfaces 115, 125 may also be coated with one or more of the above materials to achieve the same result, i.e., a "non-stick surface". For example, Nitride coatings (or one or more of the other above-identified materials) may be deposited as a coating on another base material (metal or nonmetal) using a vapor deposition manufacturing technique. Preferably, the non-stick materials are of a class of materials that provide a smooth surface to prevent mechanical tooth adhesions. As can be appreciated, reducing the amount that the tissue "sticks" during sealing improves the overall efficacy of the instrument.

It is also contemplated that the tissue contacting surfaces 115, 125 of jaw members 110, 120 can include or be coated with these non-stick materials (not shown). When utilized on contacting surfaces 115, 125, these materials provide an optimal surface energy for eliminating sticking due in part to surface texture and susceptibility to surface breakdown due to electrical effects and corrosion in the presence of biologic tissues. It is envisioned that these materials exhibit superior non-stick qualities over stainless steel and should be utilized on forceps 14 in areas where the exposure to pressure and electrosurgical energy may create localized "hot spots" more susceptible to tissue adhesion.

One particular class of materials disclosed herein has demonstrated superior non-stick properties and, in some instances, superior seal quality. For example, nitride coatings which include, but not are not limited to: TiN, ZrN, TiAlN, and CrN are preferred materials used for non-stick purposes. CrN has been found to be particularly useful for non-stick purposes due to its overall surface properties and optimal performance. Other classes of materials have also been found to reduce overall sticking. For example, high nickel/chrome alloys with a Ni/Cr ratio of approximately 5:1 have been found to significantly reduce sticking in bipolar instrumentation. One particularly useful non-stick material in this class is Inconel 600. Bipolar instrumentation having contact surfaces 115, 125 made from or coated with Ni200, Ni201 (~100% Ni) also showed improved non-stick performance over typical bipolar stainless steel electrodes.

By way of example, chromium nitride may be applied using a physical vapor deposition (PVD) process that applies a thin uniform coating to the entire electrode surface. This coating produces several effects: 1) the coating fills in the microstructures on the metal surface that contribute to mechanical adhesion of tissue to electrodes; 2) the coating is very hard and is a non-reactive material which minimizes oxidation and corrosion; and 3) the coating tends to be more resistive than the base material causing electrode surface heating which further enhances desiccation and seal quality.

The Inconel 600 coating is a so-called "super alloy" which is manufactured by Special Metals, Inc. located in Conroe Texas. The alloy is primarily used in environments which require resistance to corrosion and heat. The high Nickel content of Inconel makes the material especially resistant to organic corrosion. As can be appreciated, these properties are desirable for bipolar electrosurgical instruments which are naturally exposed to high temperatures, high RF energy and organic matter. Moreover, the resistivity of Inconel is typically higher than the base electrode material which further enhances desiccation and seal quality.

Turning back to FIGS. 2-5, when jaw members 110, 120 are actuated to grasp tissue "T", a gap "G" is defined between opposing surfaces 117, 127 of elastomeric shells 114, 124. In accordance with the present disclosure, the material of elastomeric shells 114, 124 is selected such that when jaw members 110, 120 are closed onto tissue "T', elastomeric shells 114, 124 will compress and deform in order to maintain a substantially uniform gap "G" across the portion of the jaw which is in contact with the tissue. In particular, each elastomeric shells 114, 124 will have a compression or deflection of about 0.001 inches to about 0.015 inches when the clamping force is between about 40 p.s.i. to about 230 p.s.i. (120 p.s.i. nominal) distributed over tissue contacting surfaces 115, 125 of jaw members 110, 120. In addition, it is envisioned that the elastomeric shells 114, 124 of the present disclosure allow for local pressure compensation along the length thereof to allow for sealing across non-

homogeneous structures found within the individual tissue or tissue "T" (such as, for example, bronchi and/or vascular structures found in the lung). More particularly, the elastomeric shells 114, 124 compensate for the reaction forces of vessels and tissues so that end effector assembly 100 (i.e., jaw members 110, 120) will not unintentionally damage the tissue "T" (i.e., over-compress the tissue) during the sealing process.

FIG. 2 shows one embodiment according to the present disclosure wherein electrodes 116, 126 are encased in pockets 119, 129, in shells 114 and 124, respectively. Electrodes 116, 126 preferably include an outer edge radius "R" which is designed to reduce negative tissue effects during activation. The electrodes 116, 126 may also be crowned to reduce negative tissue effects during activation. Preferably, the radiused edge "R" includes a radius of about 0.005 inches at the exposed tissue contacting edges. It is envisioned that the radiused edges, in conjunction with placing electrodes 116, 126 within pockets 119, 129 of the elastomeric shells 114, 124 reduces current densities at the inner most corner of electrodes 116, 126. Areas of high current densities may result in the unintentional damage to the tissue during sealing.

It is believed that the distance "X" between adjacent electrodes 116 and 126 plays an important role in sealing vessels. Using computer simulations and histological evidence, it has been demonstrated that a non-uniform power-density exists due to the electrical and thermal properties of tissue. This results

in a non-uniform temperature distribution in which temperature is greater in a region centrally located between the electrodes. Impedance in this central region can rise quickly creating an insulative barrier to further current flow across the tissue, resulting in inadequate sealing at the electrode edges. The greater the distance "X" is between the electrodes 116, 126 the greater the effect of the non-uniform temperature distribution. On the other hand if the distance "X" is too small, the resulting seal width may be inadequate to insure effective seal strength. Thus, it has been determined that the distance "X", the distribution of energy across the seal and the relative size of the seal itself are all important parameters which must be properly considered during the sealing process. As a result, it has been found that the preferred distance "X," as described above, is from about 0.005 inches to about 0.200 inches.

It is envisioned that all of these parameters may be monitored and regulated as a part of the disclosures herein. For example, the electrosurgical system may include one or more sensors 145, 155, respectively, which measure tissue temperature, tissue impedance, tissue pressure, light transmission, or tissue thickness prior to, during, or after the sealing process. These parameters can be relayed back to the generator 12 in a feedback loop circuit 160 to predetermine the proper amount of electrosurgical energy required to effectively seal the tissue or monitor and adjust the electrosurgical energy during the overall sealing process. Moreover, it is envisioned that the jaw members 110, 120 may be constructed such that the distance "X" is variable depending upon tissue

thickness. This can be accomplished by constructing the electrodes 116, 126 such that at least one is moveable transversely across the sealing surface or by having an array of electrodes across the sealing surfaces 115, 125. When utilizing an array of electrodes, each electrode is electrically coupled to the generator 12 to automatically select the appropriate opposing electrode pairs to effect the proper seal across the tissue depending upon the tissue thickness and tissue type.

FIG. 3 shows an alternate embodiment of the present disclosure wherein the electrodes 116a, 126a are partially disposed within the shells 114a, 124a, respectively. It is envisioned that partially disposing the electrodes 116a, 126a within shell 114a, 124a will allow the electrodes 116a, 126a to partially deflect when the jaw members 110 and 120 cooperate to grasp tissue "T". As such, gap "G" is maintained across the portion of the jaw members 110, 120 which are closed about tissue "T". In addition, portions 114a, 124a act to further insulate electrodes 116a, 126a from support members 112, 122. Accordingly, support members 112, 122 can be fabricated from electrically conductive materials without interfering (i.e., shorting or arcing) with the electrical fields being transmitted between electrodes 116a, 126a. It is contemplated that electrodes 116a, 126a may be radiused in the same manner as electrodes 116, 126 of FIG. 2.

Turning now to FIG. 4, another embodiment of the present disclosure, discloses a pair of opposing wire electrodes 116b, 126b disposed at least partially within elastomeric shells 114 and 124, respectively, more particularly, electrodes 116b, 126b are embedded in respective elastomeric shells 114, 124 such that only a portion of electrodes 116b, 126b are exposed at contacting surfaces 117, 127 of elastomeric shells 114, 124. It is envisioned that wire electrodes 116b, 126b create the same effect as radiused electrode edges and function to disperse current density. Moreover and similar to the FIG. 3 embodiment depicted above, wire electrodes 116b, 126b permit a certain degree of deflection at the tissue contacting surfaces 117, 127 which is believed to create a more uniform seal.

Turning now to FIG. 5 which shows yet another embodiment of the present disclosure wherein the jaw members 110, 120 each include a layer of elastomeric compressible material 114b, 124b disposed thereon. More particularly, each jaw member 110, 120 preferably further includes an insulating member 118, 128, respectively, having a respective layer of compressible material 114b, 124b disposed therebetween. A pair of electrodes 116c, 126c are disposed in the insulating members 118, 128 and are spaced a distance "X" across the respective contacting surfaces 117, 127. When jaw members 110, 120 close about tissue "T", the insulating members 118, 128 and the electrodes deflect by virtue of the disposition of the compressible material 114b, 124b between the jaw members 110, 120 and insulating members 118, 128.

Electrically insulative spaces may be incorporated on the tissue contacting surface (or surfaces) to control gap "G". As such, a gap "G" is uniformly maintained across the width of jaw members 110, 120 when jaw members 110, 120 are closed about tissue "T".

As can be appreciated and in accordance with the present disclosure, the end effector assembly 100 does not necessarily require a fixed electrode gap (created via a stop member between jaw members - See Fig. 7) or jaw parallelism to reduce the incidents of arcing, shorting and fluid wicking between electrodes 116, 126. In fact, due to the adjacent disposition of the opposing electrodes 116, 126, opposing surfaces 117, 127 of jaw members 110, 120 may contact with each other without causing any incidents of arcing, shorting or fluid wicking.

Moreover, the opposing offset configuration of electrodes 116, 126 according to the present disclosure also tends to minimize collateral electrical fields or current flows which, in turn, reduces unwanted thermal damage to adjacent tissue "T" located outside of the intended sealing area. In other words, the positioning of electrodes 116, 126 on opposite jaw members 110, 120 limits current flow to between the intended sealing area such that stray currents do not extend to tissue outside the lateral boundaries of jaw members 110, 120. Accordingly, enhanced current flow through the tissue is achieved.

FIG. 6 shows an alternate embodiment of the present disclosure wherein the electrode 116, 126 are disposed on the same jaw member, e.g., jaw member 120. The elastomeric material 114 is disposed on the opposite jaw member 110. Fig. 7 shows another embodiment of the present disclosure wherein at least one of the jaw members includes a stop member 135a (or series of stop members 135a-135d) disposed on the tissue contacting surface 117, 127 to regulate the gap distance "G" between opposing jaw members 110 and 120. The electrodes 116 and 126 are diametrically opposed to one another and are supported within each jaw member 110 and 120 by an elastomeric material 114a, 114b, respectively. It is envisioned that this configuration allows the electrodes 116, 126 to self-align if the alignment between the two electrodes 116, 126 is slightly skewed or non-parallel.

Although the subject apparatus has been described with respect to preferred embodiments, it will be readily apparent to those having ordinary skill in the art to which it appertains that changes and modifications may be made thereto without departing from the spirit or scope of the subject apparatus.

For example, it is envisioned that electrodes 116, 126 and/or electrodes 116, 126 and elastomeric shells 114, 124 may be selectively removable from jaw members 110, 120 (i.e., snap-fit over jaw members 110, 120) depending on the particular purpose. Alternatively, it is envisioned that

electrodes 116, 126 can be conductive strips adhered to the elastomeric shells 114, 124.

It is also envisioned that the opposing surfaces 115, 125 of jaws 110, 120 may be crowned in order to effectively stretch the tissue from the centerline of jaws 110, 120 outwardly upon the clamping or closing of jaws 110, 120. By crowning the opposing surfaces 115, 125, the elastomeric shells 114, 124 progressively collapse from the center outwardly towards their respective lateral ends thus substantially squeezing blood and other fluids out of the tissue prior to sealing. It is believed that this facilitates the sealing process by preventing entrapment of air, blood and excess fluids while placing the tissue under tension.

It is contemplated that the relative length of the electrodes 116, 126 may be regulated depending on the size of the tissue being sealed and/or the location and accessibility of the tissue being sealed.

It is further contemplated that opposing surfaces 115, 125 can be provided with gripping or grasping features, e.g., knurling, teeth, ridges, ribs, or the like, (not shown) in order to facilitate grasping of tissue "T" between jaw members 110, 120. It is still further contemplated that the jaw members 110, 120 may be constructed to close in a non-parallel manner about the tissue "T". For example, it is envisioned that the jaw members 110, 120 may be constructed to

close in a tip biased, heal biased, or independently floating manner with respect to parallel about tissue "T". It is also envisioned that only one jaw member may include the elastomeric material and the opposite jaw member may be rigid. For example, the elastomeric material 114 may be disposed on the tissue engaging surface of the jaw member 110 and the opposite jaw member 120 may be made from a rigid, non-conductive material. As can be appreciated, either jaw member 110, 120 in this instance could feasibly house the electrodes 116 and 126.

It is further envisioned that the electrically active and insulative components may be designed to minimize thermal masses in order to improve the overall thermal control of end effector assembly 100.

It is also contemplated that the end effector assembly 100 may include a dividing mechanism, such as, for example, a knife blade (not shown), which may be longitudinally reciprocable between the opposing jaws members 110, 120 to effectively and accurately separate the tissue "T" along the tissue seal.

While several embodiments of the disclosure have been shown in the drawings, it is not intended that the disclosure be limited thereto, as it is intended that the disclosure be as broad in scope as the art will allow and that the specification be read likewise. Therefore, the above description should not be construed as limiting, but merely as exemplifications of preferred embodiments.

Those skilled in the art will envision other modifications within the scope and spirit of the claims appended hereto.